ARTHRITIS IN THE ELDERLY PATIENT (OSTEOARTHRITIS)*

JOSEPH J. BUNIM

Clinical Director, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland; Associate Professor of Medicine, Johns Hopkins University, Baltimore

DR. T. W. TODD[1] wrote: "To the popular mind the aging of Man is expressed in skin and hair, and nails and teeth, in bones and muscles, in the body that has to perform the command of the will. But whereas the aging in skin and teeth, in hair and nails may take place without necessarily affecting the body as a whole, aging in the muscles and bones bites into Man's pride and gives him a sense of the passage of time which he fain would conceal even from himself. Conscious of the waning strength and endurance, he seeks for substitutes, accepting with difficulty the limitations imposed by Time and inferring therefrom a suggestion of infirmity."

Osteoarthritis, otherwise referred to as degenerative joint disease, hypertrophic or senescent arthritis, is a structural disease of joints which may develop spontaneously with advancing age (primary osteoarthritis) or at any period of life as a sequel to mechanical injury, deformity, infection, or any other condition that leads to degeneration of articular, hyaline cartilage (secondary osteoarthritis). A combination of two factors is involved in the pathogenesis of osteoarthritis. The primary factor leads to degradation of articular cartilage and the secondary one usually consists of superimposed mechanical or functional stress (such as weight bearing or excessive motion) or prolonged nutritional deficiency of the cartilage. In the spontaneous type of osteoarthritis, the primary factor is believed to consist of senescent changes in the cartilage. Whereas this aging of cartilage may occur as a generalized process, osteoarthritis develops in but few of the joints, depending, as a rule, on the mechanical conditions present locally. The exception to this rule is the very familiar arthropathy of the distal interphalangeal joints characterized by Heberden's nodes. Why these joints which are singularly free

* Presented at the 28th Graduate Fortnight on *Problems of Aging*, of The New York Academy of Medicine, October 11, 1955.

from stress or strain or excessive motion should be so commonly affected remains a mystery.

Incidence: Degenerative joint disease is the most common type of chronic arthritis. Although it affects an older age group and is not so frequently or severely disabling as rheumatoid arthritis, it, nevertheless, is of considerable economic importance. In an industrial population in New York City consisting of 23,881 persons, of whom 89 per cent were males, and the average age 45 years, it was found that degenerative joint disease was the second most common musculoskeletal disorder, being exceeded only by bursitis. Of all patients who presented objective evidence of musculoskeletal disease, degenerative joint disease (osteoarthritis) was diagnosed in 14 per cent. It occurred more frequently than gout and rheumatoid arthritis combined. The site of involvement which gave rise to symptoms was in order of descending frequency, spine 73 per cent, knees 25 per cent, hips 7 per cent and other joints 5 per cent. Symptomatic degenerative joint disease occurred in 12 per thousand employees during the year 1954.[2]

History: It is now common knowledge that osteoarthritis is among the oldest diseases in history. It is known to have afflicted prehistoric animals and Neanderthal Man (40,000 B.C.). Although Hippocrates observed that joint disease was common in the aged, a distinction between osteoarthritis and the other types of arthritis was not made until Weichselbaum[3] in 1872 accurately described the gross and microscopic changes that characterize this disease. In 1890 Sir A. E. Garrod[4] introduced the term osteoarthritis. Nichols and Richardson[5] later (1909) correctly described the characteristic pathological changes and emphasized the distinction between osteoarthritis and rheumatoid arthritis. It is interesting to note in passing that more than a century previously, Heberden[6] in 1803 had pointed out that the osteoarthritic digital nodes, which now perpetuate his name, had "no connection with gout." In 1941 the New York Rheumatism Association recommended that the term degenerative joint disease be officially used for this disease[7] and it was later adopted by the American Rheumatism Association.

Despite the ancient history of this disease, quite important contributions to our knowledge have been made within the last two decades. A better understanding of the pathogenesis of osteoarthritis in general,[8] and the knee joint,[9] hip joint,[10] and Heberden's nodes[11] in particular has been gained from critical review of past concepts, meticulous an-

alyses and sound interpretations of the characteristic gross and microscopic findings, in conjunction with application of new disciplines and technical methods, including experimental pathology, histochemistry, and angiography.

Sequence of Pathological Events: The first step in the chain of pathological events is degeneration of articular cartilage. When studied under the electron microscope, aging hyaline cartilage reveals changes in the cartilage cells, collagen fibers and interfibrillar ground substance.[12] The cells show degenerative changes containing coarse cytoplasmic granules. Calcium and fat granules appear on the fibers at the margin of the cell capsules. The architectural pattern of the collagen fibers has changed from a uniform network of fine fibers to an irregular mesh of coarse, curved fibers that retain their cross striations. The matrix loses water, becomes hardened, less elastic, less permeable and later disappears, exposing the collagen fibers. Chemical analysis of cartilage that has undergone fibrillation discloses an alteration in the ratio of collagen to chondroitin sulphate.[13] The former constitutes the fibrillar framework of the cartilage and the latter is the mucopolysaccharide of the ground substance in which the fibrils are embedded. The cartilage loses its elasticity and resilience, and its surface layers become flaked, ulcerated and denuded. Clefts and fissures appear perpendicular to the articular surface and attribute to the cartilage a felt-like filamentous appearance. As attrition advances, erosion and loss of cartilaginous substance follow. The initial stages of senescence and degeneration transpire imperceptibly; clinical symptoms do not appear until the stage of cartilage fibrillation, disintegration, and destruction is reached.

The secondary changes that follow in response to cartilage injury are productive or hypertrophic in nature. Unfortunately, the response is often vigorous and exuberant and results in further impairment of articular function. Every structure of the joint often participates in this reaction; the calcified cartilage which is at the base of the articular cartilage, the subchondral bone, synovial lining, periosteum, and capsule.

In the area where articular cartilage has been reduced in depth, the calcified cartilage becomes thicker, denser, and reduplicated. In the subchondral bone, blood vessels, fibroblasts, and endosteal cells proliferate. This vascular granulation tissue breaks through the calcified cartilage and also advances to the surface, replacing disintegrated articular cartilage. Thus, as new bone is formed and later thickened, the

articular surface which had been denuded of its cartilaginous lining is reinforced with a stout subchondral plate of bone (eburnation).

As destruction of cartilage becomes advanced and as blood vessels extend into these areas osteophytes appear, first, at the lateral margins of the joints where the synovialis merges with the articular cartilage and also where the capsule and periosteum meet. These are proliferating, bony excrescences, usually cancellous, whose marrow spaces are continuous with epiphyseal marrow. They are covered with either fibrocartilage or periosteum, never with hyaline cartilage. It is held by some investigators[10] that osteophyte formation is not limited to the marginal zones, at the junction of synovia with cartilage or periosteum, but may also occur in any area of the joint which does not transmit weight. The two prerequisites for osteophyte production appear to be destruction of cartilage and low, rather than increased, articular stress.

Changes in the synovial lining do not appear until relatively late. In striking contrast to that seen in rheumatoid arthritis, the synovial membrane is fibrotic, not inflamed or hyperemic, and only slightly and inconstantly proliferative. When fragments of disintegrated cartilage or bone are dislodged and fall to the synovial surface of the joint, phagocytosis by the lining cells occurs and hyperplasia develops.[14] This event is followed by considerable fibrous thickening and shrinkage of the joint capsule. Tightening of the capsule may contribute to the limitation of joint motion and, since the capsule is supplied with somatic and autonomic fibers, it will give rise to pain and reflex muscle spasm when stretched beyond its restricted limits.

In the pathogenesis of osteoarthritis, the productive phase just described—which includes reduplication and thickening of the calcified lamella, eburnation of subchondral bone, proliferation of osteophytes and fibrosis of capsule—occupies an intermediate position between the initial phase of cartilage degeneration and the final period of osseous destruction. As a result of ischemic changes that occur in the advanced stages, small areas of aseptic necrosis of bone develop. Probably unrelated causally to this process is the appearance of multiple bone cysts. It has recently been suggested that these cysts do not result from bone destruction since they are lined by sclerotic trabeculae and not degenerating bone. When carefully dissected, all cysts are found to communicate with the joint space by stomata. In the cysts, which range in size from 1 mm. to 2.5 cm., are present poorly vascularized fibrous

tissue, fragments of articular cartilage, and synovial fluid. Landells[15] hypothesized that the cysts arise from intrusion of the synovial fluid under pressure into subchondral bone at the site of cartilage degeneration.

The many changes which occur in the evolution of osteoarthritis—degenerative, productive, and destructive—together with the inevitable redistribution of forces acting through the joint, lead to alteration in the structure, shape, and not uncommonly to displacement of the articulating ends of the affected bone. Thus, in osteoarthritis of the hip joint, the head of the femur is characteristically flattened and extruded laterally (Fig. 5).

Factors that Contribute to Development of Osteoarthritis: Injury to cartilage is the critical factor that initiates a chain of pathological events that leads inexorably to osteoarthritis. In cases of secondary osteoarthritis, the cause of this injury is known, such as fracture, deformity, avascular necrosis, infection, neurotrophic arthropathy, gout, osteochondritis, etc. In primary or spontaneous degenerative joint disease, however, the etiology remains obscure. Undoubtedly advancing age is intimately related to the development of this disease since the articular cartilages suffer involutionary changes with aging. In 1,002 autopsies, Heine [16] determined the incidence of cartilage degeneration and of osteoarthritis in relation to the advancing decades of life. In the knee, for example, 3 per cent of subjects in the second decade exhibited cartilage changes. The incidences in each successive decade increased as follows: 9 per cent, 48 per cent, 74 per cent, 87 per cent, 92 per cent, 97 per cent and in the 9th decade it was 100 per cent. Structural evidence of osteoarthritis in this joint occurred less frequently but was again related to age; none below age 30, 1 per cent in the 4th and 5th decades and 2 per cent in the 6th decennium. From then on the incidence rose in each succeeding decade to 12, 33, and 39 per cent. Bennett, Waine, and Bauer[9] in an outstanding study on the structural changes in the knee joints of 63 persons at various ages who had presented no symptoms of joint disease reported similar findings. (Fig. 1). But senescence could not be considered the direct cause of primary osteoarthritis since this disease is not restricted to the elderly, having been encountered during the second decade; nor is there a direct relationship between age of the subject and severity of cartilage degeneration.[10]

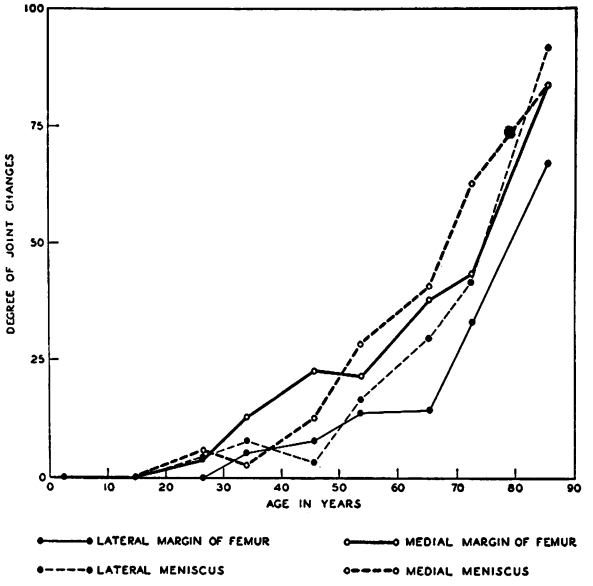

Fig. 1—Average degenerative and proliferative changes in the perichondrial margins of the femur and in the menisci at each age decade. (From Bennett, Waine and Bauer, ref. 9. Reprinted by permission of The Commonwealth Fund.)

Anatomically the distribution of degenerative joint disease is approximately equal in both sexes with the exception of terminal finger joints (Heberden's nodes) which are affected 10 times more frequently in women than in men.[17] Clinically, symptoms of osteoarthritis apparently occur more frequently in women than men.[18]

As has been mentioned, mechanical factors, like weight bearing or excessive motion, such as occur in the hip and knee or acromio-clavicular joints, contribute to the development of osteoarthritis. An important additional factor has unexpectedly and recently come to light. Trueta and associates[10] studying osteoarthritis of the hip joint with elegant techniques and unusual thoroughness concluded that the commonest sites of osteoarthritis are those sections of the femoral head and acetabulum which undergo no pressure and conversely, the areas which sustain joint pressure and carry most weight, overlying a reinforced system of bone trabeculae, survive longest in a relatively normal state. By pressure areas are meant those parts of the femoral head and acetabulum which participate in active joint functions and hence undergo

intermittent compression of movement and weight bearing. This allows, it is believed, adequate tissue-fluid exchange in the cartilage and thus promotes normal metabolism.

The role of heredity as a contributory factor to degenerative joint disease of the terminal finger joints and to a lesser degree of the hips, has been carefully assessed by Stecher.[17] It was concluded that idiopathic Heberden's nodes are inherited as a sex-influenced characteristic which is dominant in women, recessive in men, and depends upon a single autosomal gene. Accordingly, an affected woman would transmit the disease to one-half her daughters. One-half her sons would inherit the trait and would transmit it to one-half of their children although they themselves would not manifest the disease. Because Heberden's nodes are recessive in men, a man would develop them only if he inherited them from both parents. Stecher believed there was a definite association between the development of Heberden's nodes and the menopause, although in individual patients the nodes appeared at times ranging from 20 years before to 15 years after the menopause. In osteoarthritis of the hip joint, the genetic relationship is much more difficult to establish. Osteoarthritis will develop in hips that are deformed as a result of hereditary or familial disorders such as Legg-Calve-Perthes disease or congenital dysplasia of the hip. Early correction of these deformities may prevent the development of degenerative joint disease.

A number of clinical observers have recorded the impression that degenerative joint disease may be related to thyroid deficiency and others noted an association with obesity. Erdheim[19] described a type of peripheral and spinal joint disease seen in acromegaly. In view of these clinical inferences, it is of special interest to note the experimental findings of Martin and Ruth Silberberg[20] who have studied the effects of anterior pituitary hormone, fat diet, and thyroid hormone on rate of growth of articular cartilage and on spontaneous osteoarthritis in guinea pigs and mice. They found that injections of anterior pituitary, or transplants of this gland, caused intensified growth of the articular cartilage and regressive changes of cells and ground substance leading to severe degenerative joint disease. In mice fed a high fat diet, the incidence of osteoarthritis was increased two-fold and the onset of the disease significantly accelerated.[21] However, body weight per se or obesity did not appear to be an important factor in initiating articular changes. It is noteworthy that a number of animals remained free of

osteoarthritis even in old age and when fed a fat-enriched diet. The effect of such a diet on the development of joint disease was conditioned by the functional state of the thyroid. In strains of mice with inactive thyroids there was a high susceptibility to spontaneous osteoarthritis and a marked intensification of the joint disease when a high fat diet was given, whereas in mice with active thyroids, the susceptibility was low and the effect of diet only slight. The Silberbergs[22] concluded that thyroid hormone plays a major role in the maintenance of adult articular structures (in mice) under normal and abnormal conditions. Whether these provocative observations on small laboratory animals apply to man remains to be determined. Such investigations on human osteoarthritis might prove to be quite rewarding.

Clinical Features and Diagnosis: The two most common types of chronic joint disease that are encountered in middle-aged and elderly patients are osteoarthritis and rheumatoid arthritis. No one today will question that these diseases are separate and distinct nor that they can be readily distinguished from each other. It is therefore surprising to find that they are frequently confused. Since medical care is so widely divergent in both conditions, it is of considerable practical importance that a correct diagnosis be made. The basic difference between the two types of arthritis is that rheumatoid arthritis is an inflammatory and osteoarthritis a degenerative disease. There are no constitutional signs of "infection" in cases of osteoarthritis such as fever, weight loss, weakness, fatigue, generalized muscle wasting, anorexia, perspiration, anemia, leukocytosis, hyperglobulinemia and elevated sedimentation rate. In osteoarthritis of the peripheral articulations, the affected joints are painful, stiff—especially after being kept in a fixed position for a prolonged period—and somewhat tender. But they are bony, hard, irregular, or knobby upon palpation. They are not warm or pink, and soft periarticular swelling is lacking. Subcutaneous nodules are never associated with osteoarthritis and the sheep cell agglutination test is negative. The typical patient with osteoarthritis will, with the slightest encouragement, boast of aggressive good health for a person his age, save for a few stiff joints. The average patient with rheumatoid arthritis is much less sanguine and more insecure.

A common misleading feature in the differential diagnosis is the presence of swelling of the proximal interphalangeal joint. It should be remembered that one-fourth of the patients with degenerative joint

disease who have Heberden's nodes also have involvement of the proximal finger joint.[11] In this disease the joint is bony, hard, and irregular, and the metacarpophalangeal joints are remarkably unaffected. X-rays of the hands show osteophytes, eburnation and absence of osteoporosis at the phalanges; with rare exception, the heads of the metacarpal bones and the contiguous joints are well preserved (Fig. 2).

In osteoarthritis of the intervertebral articulations of the spine, hypertrophic bone changes may cause narrowing of the foramina with resulting irritation and compression of nerve roots. The symptoms will of course vary with the spinal segments involved. Collins[8] made a useful and clinically important distinction between osteoarthritis and osteophytosis of the spine. The term osteoarthritis is limited to synovial-lined, diarthrodial joints; hence such a diagnosis is restricted to degenerative disease of the interfacetal or apophyseal articulations. The term osteophytosis is used to describe the formation of spurs on the margins of the vertebral bodies which are so commonly seen in x-rays of the spine of middle-aged people (Fig. 3). These osteophytes rarely give rise to symptoms although they are too often indicted.

In Figures 4 and 5 are illustrated typical x-ray changes seen in osteoarthritis of the knee and hip.

Treatment: The one remedy most frequently effective is the simple assurance by the physician that the patient does not have rheumatoid arthritis and consequently is not threatened with invalidism or crippling deformity of multiple joints. Since medical treatment is always palliative and disability from this disease rarely severe, there generally is little justification for the use of drugs that are potentially hazardous such as steroids (systemic administration), corticotropin, or phenylbutazone, or for drugs that are of no proved value such as colchicine, cinchophen, iodides, snake venom, liver extracts, vaccines, or antibiotics. Hormonal therapy such as thyroid, estrogens and androgens should be administered only when there is evidence of a specific deficiency. Rest for the affected joints, physical therapy, corrective exercises, and aspirin are beneficial. Obesity should be corrected, and a sustained and earnest effort at weight reduction should be made. Repeated intra-articular injections of 25 mg. of tertiary-butylacetate or the acetate of hydrocortisone is often quite helpful in tiding the patient over a troublesome period.

Corrective surgical measures are considered in but a small percentage

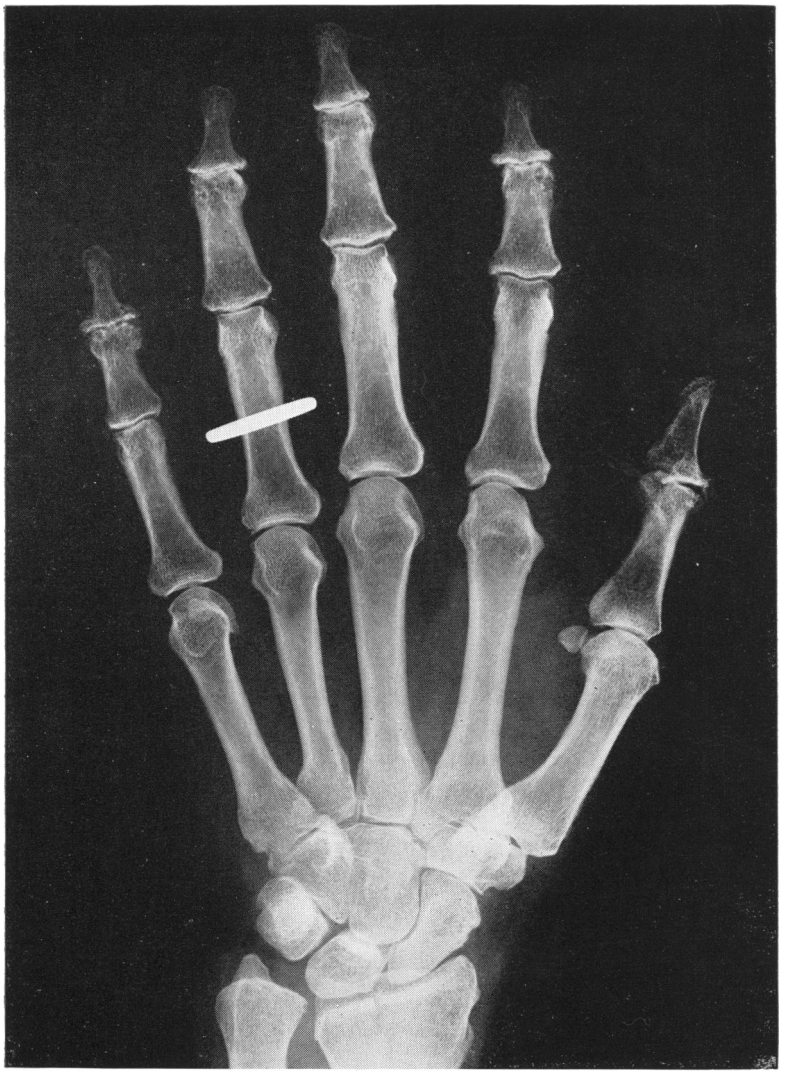

Fig. 2—Photograph of x-ray of left hand of 63 year old white female illustrating typical changes associated with osteoarthritis of terminal finger joints (Heberden's nodes). The joint spaces are narrowed, irregular and uneven, and the joint surfaces widened. The subchondral bone is of increased density (eburnation). Multiple small cysts are present in the distal ends (subchondral bone) of the middle phalanges. An osteophyte appears at base of terminal phalanx of thumb. The metacarpophalangeal joints are unaffected.

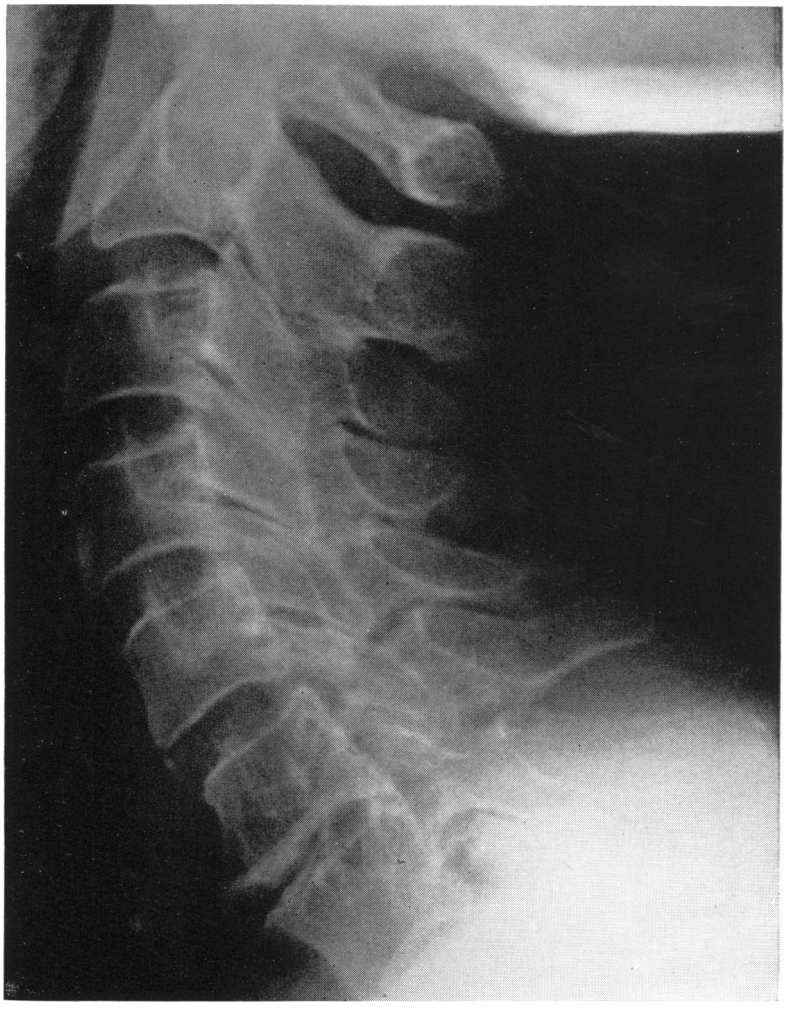

Fig. 3—Photograph of x-ray of cervical spine (lateral view) of 74 year old white female, illustrating osteophytosis at the inferior border of the sixth and superior border of the seventh cervical vertebra (both anteriorly and posteriorly). The intervertebral space is narrowed as a result of disc degeneration. Eburnation is seen at the opposing surfaces of the affected vertebral bodies.

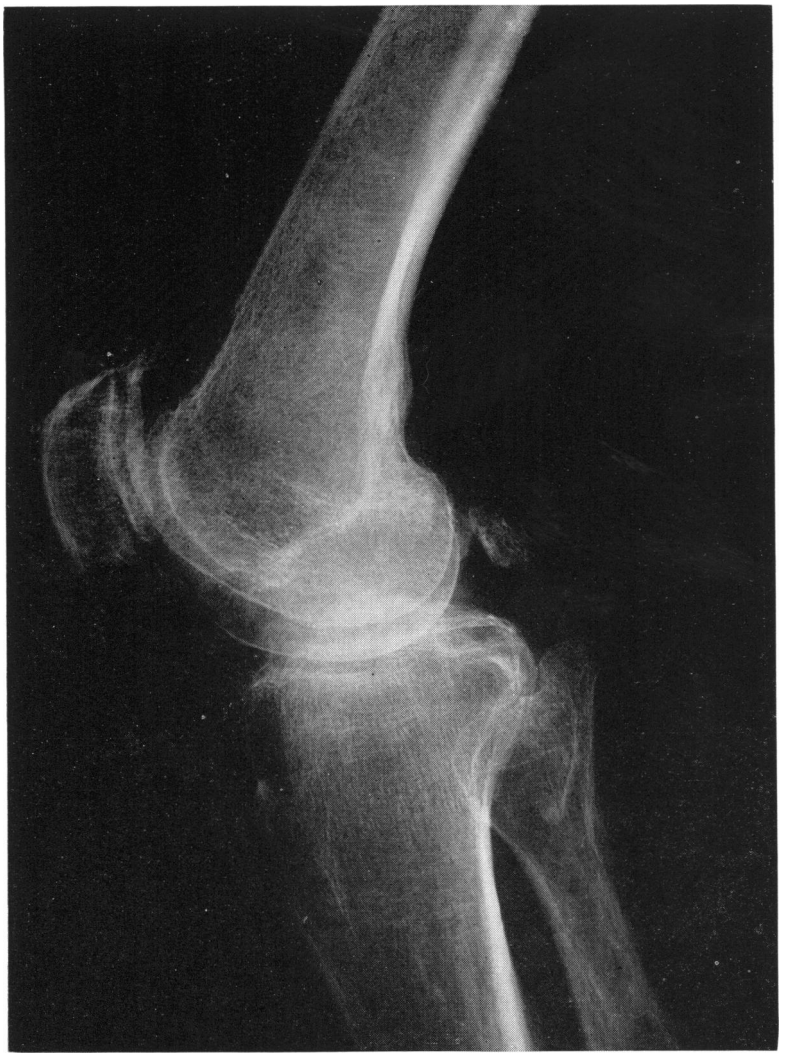

Fig. 4—Photograph of x-ray of knee (lateral view) of 70 year old white female. Spurs extend from anterior, posterior and inferior surfaces of the patella. As a result of destruction of the articular cartilages, the retropatellar space and the space between the femoral condyles and tibia are narrowed. A large ossified loose body appears posterior to the femoral condyles.

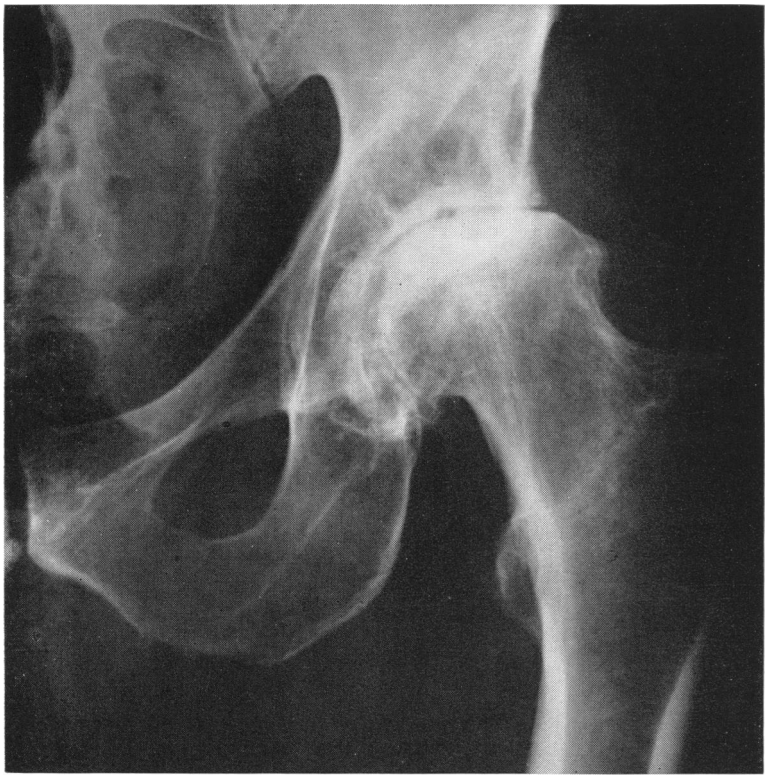

Fig. 5—Photograph of x-ray of hip of white male, age 62, illustrating typical changes associated with osteoarthritis of the hip joint. Destruction of cartilage and bone is seen (malum coxae senilis). The joint space is markedly uneven, narrowed in the superior aspect and widened in the inferior portion. The head of the femur is characteristically flattened. There is increased density (eburnation) of the subchondral bone of the acetabulum and femoral head. Overgrowth of bone at the inferior margin of the femoral head is present. Multiple cysts appear in the juxta-articular bone on both sides of the joint.

of advanced cases of knee or hip involvement associated with insufferable pain or serious disability. A variety of surgical procedures has been recommended. These include fusion of the joint (arthrodesis), arthroplasty, debridements, neurectomy, synovectomy, and patellectomies. The literature on these measures is both abundant and controversial. The subject is too complex to be adequately discussed in this paper, even if the author were competent to do so.

REFERENCES

1. Todd, T. W. Skeleton and locomotor system, in Cowdry, E. V. editor, *Problems of ageing,* 2. ed., Baltimore, Williams & Wilkins Co., 1942, pp. 322-365.
2. Brown, R., Lingg, C. and Mainland, D. Personal communication of unpublished data.
3. Weichselbaum, A. Arthritis deformans der beiden Schulter-und Ellbogengelenke und des linken Hüftgelenkes, *Virchows Arch. path. Anat. 55:*217-28, 1872.
4. Garrod, (Sir) A. E. *A treatise on rheumatism and rheumatoid arthritis.* London, C. Griffin & Co., 1890.
5. Nichols, E. H. and Richardson, F. L. Arthritis deformans, *J. med. Res. 21:* 149-221, 1909.
6. Heberden, W. *Commentaries on the history and cure of diseases.* 2. ed. London, T. Payne, 1803, p. 148.
7. Welfare Council of New York City, Committee on Chronic Illness, Subcommittee on Arthritis. *Classification and criteria of various types of arthritis.* 1941.
8. Collins, D. H. *The pathology of articular and spinal diseases.* London, E. Arnold & Co., 1949.
9. Bennett, G. A., Waine, H. and Bauer, W. *Changes in the knee joint at various ages.* New York, Commonwealth Fund, 1942.
10. Harrison, M. H. M., Schajowicz, F. and Trueta, J. Osteoarthritis of the hip; a study of the nature and evolution of the disease, *J. Bone Jt. Surg. 35B:*598-626, 1953.
11. Stecher, R. M. Heberden's nodes; a clinical description of osteoarthritis of the finger joints, *Ann. Rheum. Dis. 14:* 1-10, 1955.
12. Zbinden, G. Über Feinstrukter und Altersveränderungen des hyalinen Knorpels im elektronenmikroskopischen Schnittpräparat und Beitrag zur Kenntnis der Verfettung der Knorpelgrundsubstanz, *Schweiz. Z. allg. Path. 16:*165-89, 1953.
13. Matthews, B. F. Composition of articular cartilage in osteoarthritis, *Brit. med. J. 2:*660-61, 1953.
14. Lloyd-Roberts, G. C. The role of capsular changes in osteoarthritis of the hip joint, *J. Bone Jt. Surg. 35B:*627-42, 1953.
15. Landells, J. W. The bone cysts of osteoarthritis, *J. Bone Jt. Surg. 35B:* 643-49, 1953.
16. Heine, I. Über die arthritis deformans, *Virchows Arch. path. Anat. 260:*521-663, 1926.
17. Stecher, R. M. Hereditary factors in arthritis, *Med. Clin. N. Amer. 39:*499-508, March 1955.
18. Waine, H. The nature of degenerative joint disease, *Ann. west. Med. Surg. 2:*313-19, 1948.
19. Erdheim, J. Über Wirbelsäulenveränderungen bei Akromegalie, *Virchows Arch. path. Anat. 281:*197-226, 1931.
20. Silberberg, M., Silberberg, R. and Opdyke, M. Degenerative joint disease in mice bearing anterior hypophyseal, ovarian and adrenal grafts, *Endocrinology 54:*26-34, 1954.
21. Silberberg, M. and Silberberg, R. Effects of a high fat diet on the joints of aging mice, *Arch. Path. 50:*828-46, 1950.
22. Silberberg, M. and Silberberg, R. Role of thyroid hormone in the pathogenesis of joint disease in mice; effects of radiothyroidectomy and high-fat diets, *J. Bone Jt. Surg. 37A:*537-48, 1955.